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ABSTRACT

This study investigates how successful the Urban Alternative Preparation Program (UAPP) integrated mathematics/methods sequence was at changing the beliefs and practices of preservice teachers in the program. The program is grounded in constructivist learning theory and promotes practices that support that perspective. A group of eight students who held non-education undergraduate degrees and were preparing to become certified in a K-5 urban setting participated in the study. Results indicate that they demonstrated beliefs and practices that were more consistent with the philosophy of reform and a strong resilience in their newfound beliefs and practice. (KHR)

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THE STORY OF FIRST-YEAR TEACHERS' STRUGGLE TO MAINTAIN A REFORM PERSPECTIVE AFTER EXPERIENCING INTEGRATED MATHEMATICS CONTENT AND METHODS IN THEIR TEACHER PREPARATION PROGRAM

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Rationale and Theoretical Perspective

For the last two decades, constructivism (Confrey, 1987; Gergen, 1992; Phillips, 1995) has emerged as the epistemological foundation for mathematics learning. A vision of how to teach within such a theoretical framework has materialized (Simon, 1995; Steffe & D'Ambrosio, 1995) and the research community has explored teacher change from this perspective (Ball, 1994; Fennema & Nelson, 1997; Hart 1993, 1994; Schifter, 1995, 1998). One significant component of the research has been the role of beliefs in teacher change. Over time, a substantial body of literature has emerged providing evidence that teachers' beliefs drive their teaching of mathematics (Pajares, 1992; Richardson, 1996). In order to change teachers' practices, we need to consider teachers' beliefs. However, we know that beliefs are difficult to change (Lerman, 1997), that the beliefs teachers' espouse are not always consistent with the way they teach (Brown, 1985; Cooney, 1985), and that changing teachers' beliefs takes time (Richardson, 1996). Moreover, Pajares (1992) tells us that beliefs about teaching are well established by the time a student enters college. They are developed during what Lortie (1975) calls *the apprenticeship of observation* that occurs over their years as a student. They include ideas about what it takes to be an effective teacher and are brought to their teacher preparation program. Given this, it seems imperative that teacher education programs assess their effectiveness, at least in part, on how well they nurture beliefs that are consistent with the program's philosophy of learning and teaching. Also, it is important to study how consistent the beliefs teachers espouse are with their teaching practices, i.e., can teachers do more than *talk the talk?*

Since most beliefs are formed through experience over time, pedagogical practices that support constructivist theory can be nurtured if we engage novice teachers in constructivist experiences both in learning mathematics and in teaching mathematics. This does not insure change, but certainly facilitates it. However, change is limited when preservice teachers learn mathematics content differently than they learn mathematics methods. Given the limited amount of time preservice programs have to impact teacher development, if the mathematics is taught by lecture and the methods use a constructivist environment, the experience is diluted and the chance for change is significantly decreased.

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The Intervention: The Urban Alternative Preparation Program

The Urban Alternative Preparation Program (UAPP) is housed in the Department of Early Childhood Education at a large, urban university. Students enter the program as a cohort, taking all coursework together. The students hold non-education undergraduate degrees and are preparing to become certified in a K-5 *urban* setting. The program is grounded in constructivist learning theory and promotes practices that support that perspective. In Phase I of the program, students obtain certification after four semesters. Coursework in Phase I includes four math-related courses: two courses in mathematics content and two courses in mathematics education. To participate in Phase II students must accept jobs teaching elementary school in an urban setting (defined for our purposes as schools with at least 75% free or reduced lunch). During this time students pursue a masters degree. Their coursework during Phase II includes receiving coaching in mathematics (content and methods) in their individual classrooms and a university course on Issues in Teaching Mathematics.

During the first year of the program, I taught the twelve semester hours of content and methods as an integrated, seamless course over three consecutive semesters. Instruction was consistent with a constructivist philosophy. Students learned the mathematics from the mathematics book using many of the methods suggested in the methods book. We used oral reflection, videotaping and written logs to examine the methods used to deliver the content. During Phase II (as part of their masters program) I mentored these same teachers through monthly visits to their classrooms. In addition, I taught the Issues in Teaching Mathematics course that teachers attended as a group to collaborate and reflect on their practice. Part of that coursework was completed on the web.

Participants

Fourteen of the original cohort of 20 teachers completed Phase I and obtained certification. Only 8 teachers actually took a teaching position in an *urban* school and are part of this study. They ranged in age from 25 to 41. There were two African-American females, one Asian male and five Caucasian females. Two teachers were in a first grade classroom, five teachers were in a second grade and one was in a third grade classroom.

Methods

In order to assess how successful the UAPP integrated math/methods sequence was at changing the beliefs and practice of the preservice teachers in the program, a study was conducted through Phase I – Teacher Certification. To assess change in beliefs and consistency of beliefs with practice, three data sources were used. A Mathematics Beliefs Instrument (MBI) was administered before and after Phase I. In addition the participants routinely completed reflection logs describing their experiences in teaching mathematics in their field placements, and I observed their practice through

regular classroom visits to their placements. Results from this work suggested that teachers had in fact changed their beliefs in a direction more consistent with reform practices and their practice was somewhat consistent with their beliefs (Hart, in press). However, that research was only the first step in assessing the impact of the program.

As the mathematics coach for Phase II, I had the opportunity to follow these teachers into their first year in an urban school. I was able to observe in their classrooms and to continue to study their change. To study their practice and beliefs I collected data from three sources. First, at each of the whole-group class meetings teachers completed reflection logs about their teaching of mathematics. Second, teachers responded to web assignments that required them to write about other teachers' practice through case discussions (Stein, Smith, Henningsen & Silver, 2000; Schifter, 1996). Third, field notes were made during observations in teachers' classrooms. These data sources provided a triangulation of perspectives: the teachers' view of themselves, the teachers' view of others and my view of them. All of these data were analyzed using qualitative methods, looking for themes that emerged about their practice and beliefs. Finally, the MBI was administered again at the end of their first year of teaching and compared to the results from the previous year. Descriptive statistics were used to describe general trends in their change.

Results

Practice

Personal reflection logs. Perhaps the most vivid theme that emerged from the data at the beginning of the school year was the teachers' frustration at the deeply rooted, traditional mathematics culture of their schools and their incredible struggle at confronting this culture. In the first few months they describe their schools' mathematics curricula as very traditional, skill-driven programs. Many of the schools did grade level planning in which one person planned the mathematics lessons for the entire grade level for the week. Lessons frequently consisted of pages to cover in the book and worksheets. As new teachers, these students expressed frustration at this kind of work. One teacher wrote, "As the new kid on the block I am afraid to speak up and challenge what these teachers are saying. I want to be accepted and not appear to be a trouble maker." Another teacher stated "I think I am going to offer to be the planner for math, so I can try to suggest some new things." A third said, "I try to go along with what they suggest and then go in my room and do what I know my kids need, but I am always behind everyone else!" They were caught between the beliefs and values they learned in the UAPP program and norms of the environment in which they were working.

As the year progressed they began to turn their attention to their students' learning and made statements in their logs that suggest that their resolve was shaken but not altered. They communicated that they really believe the philosophy and values of the

reform. They wrote, "my best math instruction often occurs spur of the moment from the kids ideas"; "these kids *need* to manipulate most of the time to work through the problems not just do workbook pages"; " my kids are explaining their strategies and loving it – they get so excited it can cause management problems"; "sometimes it is hard to get them to think about number sense, they want me to tell them"; and, "my children are stuck by 'work book' ways of problem solving. It's difficult to get them out of the box."

Their perspective seemed undaunted by the incredible roadblocks they encountered throughout the year, e.g., pressure from administrators to emphasize skill development in order to do well on standardized tests, colleagues who alienated them for their unorthodox methods, students who balked at 'sharing their thinking", limited resources, and limitations in their own understanding of the content. Yet in their reflections at the end of the year the teachers repeatedly articulated their continued support of a reform approach to teaching mathematics. They commented, "we were taught to make the children think, rationalize and to not just accept what is said to be true. I still believe in all of those things very deeply, but boy is it a difficult task within the schools and school systems where we are placed"; "I believe that it is not only possible but in the best interest of the child to teach mathematics as we have been taught in class"; "I totally think it is possible and vital to the students in an urban setting to teach the way we were taught"; and, "I absolutely believe that it is possible to teach mathematics the way you have promoted in an urban setting". One first grade teacher tells the story this way: "On some of those days when my energy has been drained to nothing and my optimism torn to shreds, I kind of look over into the 'greener' field of worksheets and books where the teachers are full of energy and flowing from topic to topic, and wonder if maybe I can linger there for a month or two to regain my energy. And then it happens . . .a cute, big-headed little boy looks at me and says 'Look Ms. Lowe, 2 tens and 17 ones makes 37 too . . . I just traded in one of my tens sticks!' Those days of working with the Unifix cubes, Popsicle sticks, and bean sticks have paid off. Then I look in *my* field and realize that their fundamental understanding will be the foundation of years of math learning. I will trade my weariness for *that* any day . . ."

Case discussions. The most striking theme in their written case discussions was the teachers' ability to think deeply about the methods and strategies a teacher was using and how little they were able to comment on the mathematics content of the case. For the most part their observations reflected a real awareness of methods that supported a reform philosophy and those that did not. For example, they noticed immediately that a teacher in one of the cases "was quick to cave in and give the algorithmic procedure for solving the problem when their students became frustrated." They also noticed when a teacher, " didn't give them an algorithm to plug into but redirected the students back to the diagram for understanding." They had more insights, giving more elaborate comments. For example, one teacher commented on a case in

which the same lesson plan was presented to two different sections of students, "Ron's stressful reaction to *his* time limits for the class and his underlying need to rush the students through the lesson without allowing them any real time to reflect reduced the cognitive demands of the second period class. In the second period he resorted too quickly to providing the students with the algorithm due to time constraints and his fear of their frustration. In the 6th period he relaxed a bit and stuck to his original plan-prompting the students to use the diagram/visuals provided to encourage thinking." However, when asked to comment on the mathematics in a case, such as a statement when a student in the case says "Are you saying that 100% = 1? I thought that 100% = 100!", few of the teachers were able to talk about the *mathematics* very deeply and a few revealed some shocking misconceptions. For example one student said "We commonly think that the whole is always 100%, when it actually depends on what the given problem is." While others saw the potential richness for the mathematical discussion, their comments were quite brief, often limited to one sentence. "It is important to know what 100% is in relation to the problem." "It is important to know when switching from decimals to percents." "His statement will better help someone understand what is happening." They seemed to feel very comfortable analyzing the teacher's methods and his or her alignment with reform practice, yet there was little discussion of the mathematics itself and why it was difficult or where potential misconceptions might lie.

Classroom observations. Classroom observations at the beginning of the year mirrored the conflict teachers' expressed in their logs. Their practice showed a tremendous effort to implement reform practice but also frequently would revert back to what might be called traditional strategies. For example, in an observation of Mona during her third month of teaching her class was working on basic facts. Mona had developed an activity in which her children drew dots on eight Popsicle sticks (a stick with one dot, a stick with two dots, a stick with three dots and so on). Mona then held up her own stick with, say, five dots. She posed the problem. "Can you show me this many dots using other sticks that you have?" After a long silence in which Mona later declared she almost gave up, one very shy boy held up a stick with two dots and a stick with three dots. Others slowly caught on and Mona encouraged conversation from the students about how they had figured out their solution. After several more problems of this type she had the students open their workbook and do the page of 25 basic number facts that was assigned by the grade level for completion for that day.

By spring their convictions were holding. For example, in one observation a teacher was reviewing addition of one digit plus two digit addends by using a missing addend vertical format ($7 + X = 15$). She required each student to explain "how" he or she had solved the problem. One student had used doubles (7+7=14 and 1 more) and another student had counted on (7, 8, 9, . . .). The teacher next gave the problem ($9 + X = 15$). The class proceeded through another explanation and at the end a student

commented that he could do $8 + X = 15$ using what he knew from the two previous problems. The teacher encouraged the student to explain and used that idea to build other related problems, like 6+X, 5+X, etc. Through discussion the students saw more patterns where they could use existing problems to help them solve more related problems, e.g., (3+X=15 and 12+X=15). Examples like this were seen in other classes. For the most part teachers had not given in to the pressures of traditional instructional norms and in many cases were feeling more comfortable in their role as a classroom teacher and showing more creative methods for traditional content.

Beliefs

In both the reflection logs and the case discussions their comments continued to show strong alignment with reform mathematics and with the beliefs they had expressed in the study at the end of Phase I. For example, at the end of student teaching Tiffany responded *more false than true* to the statement that "Math problems can be done correctly in only one way" (MBI, Item #23). In the case writings she commented: "Too often students are intimidated by math because of the fact that there is only one right answer. What students fail to realize is that the problem can be solved in many different ways." Clearly demonstrating a consistency in her responses. Another student, Jessica, responded *disagree* to item #10 on the MBI (In K-5 mathematics, skill in computation should precede word problems). In her log she wrote, "I think concepts should be taught before algorithms, because if we know the algorithm one doesn't tend to try and understand why it works just to do the problem and get a correct answer." Other comments consistent with reform philosophy were found. "It is kind of hard to get the students to think about number sense stuff. They always want a rule." "The students need to explain their strategies." "It's important to give the students enough time to explore the concept." It's hard to get the students to slow down and explain everything to a partner, but it is so important!"

Finally, the MBI results from the end of Phase I to the end of Phase II found that of the 223 possible response changes in self-reported beliefs (28 items x 8 teachers with one item omitted), 81.6% (182 items) remained unchanged, 9.0% (20 items) changed in a direction more consistent with reform philosophy, and 9.4% (21 items) changed in a direction away from reform philosophy. Further item analysis of the 21 changed items found that only 3 items changed more than 1 degree on a 4 point Likert scale, for example items changing only one degree may have changed from TRUE to MORE TRUE THAN FALSE. The three responses that had more than one degree of change came from three different teachers.

Comments

This project followed a group of 8 teachers who participated in a two-year alternative preparation program to become elementary teachers in urban classrooms. During the first year (Phase I) they participated in integrated mathematics content/

mathematics methods coursework and were supervised in their mathematics teaching by the same instructor. At the end of that first year they demonstrated beliefs and practice that were more consistent with the philosophy of reform. During the second year (Phase II) of the program they were coached in their classrooms and participated in coursework again by the same instructor. At the end of that experience the teachers demonstrated a strong resilience in their newfound beliefs and practice.

What did we learn from these results? As preservice teachers the participants had experienced all their placements in urban classrooms where they observed, almost without exception, traditional practice; however, they were clearly not prepared for the difficulty in working within such a culture. This is important information as we develop and reform our professional program. It appears that even in the face of this frustration they held on to beliefs that are consistent with reform practices. They appear to understand and value student construction of knowledge and the importance of exploring the content they are teaching. They have attempted to integrate behaviors that support these beliefs within the traditional culture within which they work. They appear to believe reform practices can and will work in urban setting. We also learned that while the integration of content and methods appeared to provide a solid foundation for establishing new beliefs about teaching and learning mathematics and about pedagogical methods that supported a reform philosophy, the mathematics content was still not sufficiently developed to produce teachers who felt confident in their understanding of much of that content. This is clearly an area that deserves attention as we plan future iterations of the program. Teaching within a reform philosophy requires a deep understanding of elementary mathematics content. These teachers seem to understand their own limitations in this area.

The study is clearly limited by the small number of teachers I was able to follow through the two-year program. The results, however, are useful to us as we plan for the future. It is important that we prepare teachers for working in a culture that may not be supportive of their philosophical position about learning and teaching mathematics. They must understand that there will be many different perspectives about what it means to know and do mathematics. We must also attend to the need for developing deeper content knowledge of elementary mathematics. The integrated content and methods presented within an environment that supports a constructivist theory of learning appeared to facilitate the development of beliefs that were consistent with a reform position. However, there was insufficient time to attend to the complex and diverse content issues they needed. As mathematics educators we need to think deeply about how we can impact preservice elementary teachers more deeply within the limited amount of time we have to work with them. Ma & Kessel (2001) state " . . . content and pedagogy may be two sides of the same coin." (p. 16). I would amend that slightly and say that content and pedagogy should be two sides of the same coin.

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